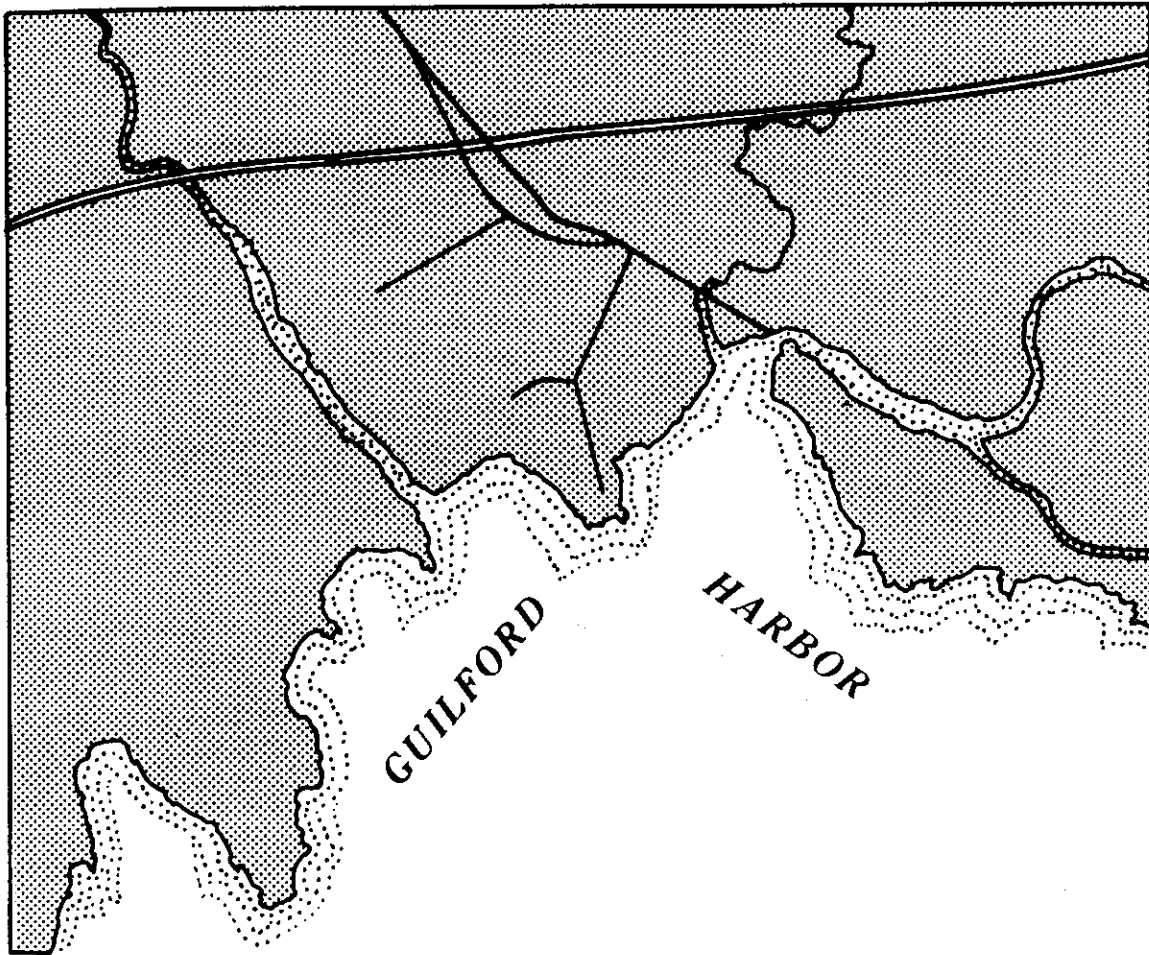


NAVIGATION AND BEACH EROSION CONTROL STUDY FOR



FILE COPY



GUILFORD SHORES

Guilford, Connecticut

43

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

FEBRUARY, 1976

NAVIGATION AND BEACH EROSION
CONTROL STUDY OF GUILFORD SHORES
GUILFORD, CONNECTICUT

TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Subject</u>	<u>Page No.</u>
1	Authority	1
2	Purpose and Extent of Study	1
4	Alternatives Investigated to Correct Navigation Problems	2
7	Alternatives Investigated to Correct Beach Erosion Problems	3
11	Conclusions	4
12	Recommendations	4

APPENDICES

<u>Appendix</u>	<u>Subject</u>
A	Report, Economic & Environmental Feasibility Beach Erosion Control and Navigation Guilford Harbor, Guilford, Connecticut
SR-1	Information called for by Senate Resolu- tion 148, 85th Congress, adopted 28 January 1958

PLATES

<u>Plate No.</u>	
1	Navigation Improvements
1A	Navigation Improvements
2	Navigation Improvements
3	Beach Erosion Improvements
A-1	Vicinity Map
A-2	Navigation Small Anchorage
A-3	Large Anchorage and West River
A-4	Beach Erosion



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO
NEDPL-C

10 February 1976

SUBJECT: Survey (Review of Reports) Guilford Shores
Guilford, Connecticut - 10005

HQDA (DAEN-CWP-E)
WASH, DC 20314

1. Authority. This report of survey of Guilford Harbor, Connecticut is submitted in compliance with a resolution adopted December 2, 1971 by the Committee on Public Works of the U. S. House of Representatives, which reads as follows:

"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on Guilford Harbor, Connecticut published as House Document No. 149, 77th Congress, 1st Session, and other pertinent reports, with a view to modifying the existing project in the interest of navigation and related purposes. BE IT FURTHER RESOLVED that in accordance with Section 110 of the River and Harbor Act of 1962, the Secretary of the Army is hereby requested to direct the Chief of Engineers to make a survey of Guilford, Connecticut, and adjacent areas as may be necessary in the interest of beach erosion control and related purposes". By letter dated 7 January 1972, the Chief of Engineers assigned the study to the Division Engineer, New England.

2. Purpose and Extent of Study. The investigation was made to determine the best means for preservation and development of the entire shorefront in the interest of beach erosion control and expansion of navigation improvement facilities. To determine the specific desires of local interests for purposes of the study a public meeting was held in Guilford on 29 August 1973. Town officials and local residents expressed interest in the following:

A breakwater and anchorage in the harbor; a channel in the West River protected by a breakwater at the mouth; restoration of the shoreline

in various locations; removal of obstructions in the East River Channel; additional bathing facilities at two beach areas; improvement to the revetment at the Town Marina located at the entrance to East River; reduction of shoaling in Sluice Creek and beach erosion control outside the study area at Indian Cove, Joshua Cove and Circle Beach in Madison.

3. In order to expedite completion of the survey report at an early date, the New England Division contracted with a consulting engineering firm to undertake an economic and environmental feasibility study based on the expressed interests of local residents. The detailed findings of this study are inclosed as Appendix A of this summary report. During the course of the study town officials were consulted to clarify all of the desires of local residents and to collect all pertinent information concerning the area involved. The study was coordinated with all Federal and State agencies concerned with development and protection of the environment. These agencies were given the opportunity to comment on all phases of the investigation and its resulting conclusions.

4. Alternatives Investigated to Correct Navigation Problems. Several possible alternatives to satisfy the needs for increased recreational and commercial boating activities were investigated during the course of the study, three specific plans of improvement for the main harbor were considered. Plate I details a plan providing for dredging a new channel from the Town Marina to deep water with anchorage areas on either side of the channel totaling 25 acres, protected by a breakwater extending from Grass Island southwest and then northeast to the vicinity of Guilford Point with a gap at its intersection with the navigation channel; a second plan considered, shown on Plate IA, would provide for a breakwater from the tip of Grass Island to the outer end of the existing channel, a gap for the existing channel, then a continuation of the breakwater to the vicinity of Guilford Point inclosing an anchorage area of 25 acres. The third plan considered would provide for a breakwater at the mouth of the East River inclosing an anchorage area of 10 acres.

5. The annual benefits and costs for each plan were developed based on analysis factors described in the report. Benefit-cost ratios for each plan considered indicated that there are not sufficient benefits to justify Federal participation in construction of any of these plans.

6. Because of the shallow depths at the mouth and in other reaches of West River, boating activity is limited to small craft. The

solution considered was to dredge a channel 6 feet deep 100 feet wide outside the river and 60 feet wide in the river leading from deep water in Long Island Sound, upstream to the existing yacht club on the east bank of the West River (see Plate 2). However, because of the rapid shoaling characteristics of the river, the channel would be subject to frequent maintenance dredging. In view of the lack of disposal sites within an economical distance for either ocean disposal or hydraulic pumping to an onshore site, construction and maintenance would be extremely costly. Comparison of benefits and costs for the considered improvement resulted in a benefit-cost ratio of 0.36 to 1.0. It was then considered that breakwater protection, 1000 feet long for the outerportion of the channel might reduce the maintenance dredging cost. However, amortization of breakwater protection would far exceed the cost of maintenance dredging that could be reduced.

7. Alternatives Investigated to Correct Beach Erosion Problems. Isolated portions of the shoreline particularly salt marsh areas have been receding at a rate of 2 1/2 feet per year. In some areas where revetment has been placed, the revetment is either too low and the back shore becomes subject to damage from overtopping or the revetment is in need of restoration and strengthening. Further loss of land could be reduced by placement of sandfill along the shore face of the marsh areas west of Chaffinch Island, at Chittenden Beach, the area adjacent to Jacobs Beach, and the south shore of Grass Island. In lieu of or in conjunction with sandfill, wave barriers such as jetties or groins could be placed at various locations at Chittenden Beach, Jacobs Beach and Grass Island to improve the stabilization of the shoreline. The eroding areas could also be protected with the addition of revetments, seawalls or similar structures.

8. Revetment protection was selected as a representative method of stabilizing the eroding marsh shorelines. However, in view of the land value for marshland the annual benefit derived amounts to \$0.03 per foot of eroding face as compared to a minimum cost of \$18 per foot for revetment protection. Other methods of shoreline stabilization would be similarly expensive.

9. The existing bathing beaches are not presently used to capacity due chiefly to a lack of adequate access and parking facilities. However, population projections indicate that beach crowding will definitely increase over the next 50 years. Improvement of bathing beaches was considered by addition of sandfill to provide additional bathing capacities and to stabilize the shorelines in these areas. Possible sites for additional beaches included the south and west sides of Grass Island, Jacobs Beach, Chittenden Beach and an area west of Chaffinch Island. After thorough consideration of environmental

and economic factors, it was determined that Chaffinch Island and Chittenden Beach were the only reasonable sites for beach expansion and improvement. Bathing benefits were based on the assumption that the beach would serve as an overflow from Hammonasset Beach and Jacobs Beach, provided that suitable parking facilities were made available. It was further assumed to evaluate beach use benefits that the capacity of Chittenden Beach would be 1,000 people. Erosion prevention benefits were based on the assumption that the shoreline would continue to erode at the rate of 2 1/2 feet per year without beachfill. Improvement of Chittenden Beach sufficiently to accommodate the anticipated crowding would involve placement of sandfill with a jetty at the west end to stabilize the beach. The annual cost for this improvement was estimated to be \$23,400 while the total annual benefits derived from bathing improvements and shore protection amounts to only \$3,600, resulting in a benefit-cost ratio of 0.16 to 1 for Chittenden Beach.

10. Chaffinch Island Beach was also considered for improvement which would provide bathing and erosion prevention benefits. Improvement benefits are based on similar reasoning of providing space for an overflow from Hammonasset Beach of 300 person capacity for 14 peak day overflows per year. Shore erosion prevention benefits would be the same as Chittenden Beach based on a per linear foot loss. The cost of sandfill for Chaffinch Island Beach was estimated at an annual cost of \$7,300. The benefit cost ratio for this improvement project would be 0.2 to 1. The beach erosion improvements considered are shown on Plate 3.

11. Conclusions. As a result of the study it has been concluded that none of the specifically considered proposals to improve navigation or provide beach erosion control are economically justified for Federal participation. This does not preclude construction of the plans or some modification of them by local interests. Nor does it limit or prevent the development of marina facilities. Federal participation in cost sharing is limited under present law to improvements such as dredging channels and anchorages and construction of breakwaters and jetties for navigation improvements. Where beach erosion control is concerned Federal participation is limited to construction of economically feasible projects consisting of sandfill groins and revetments fronting publicly owned land. Study results indicate that Federal participation in the considered projects is not warranted due to the lack of economic benefits.

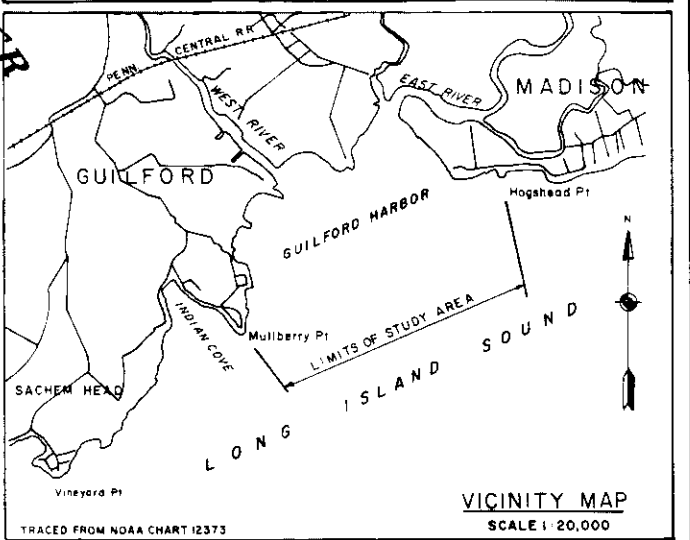
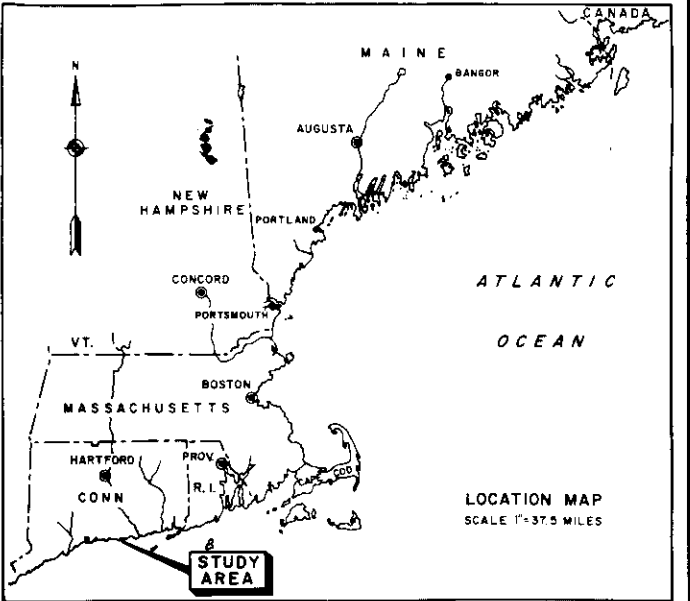
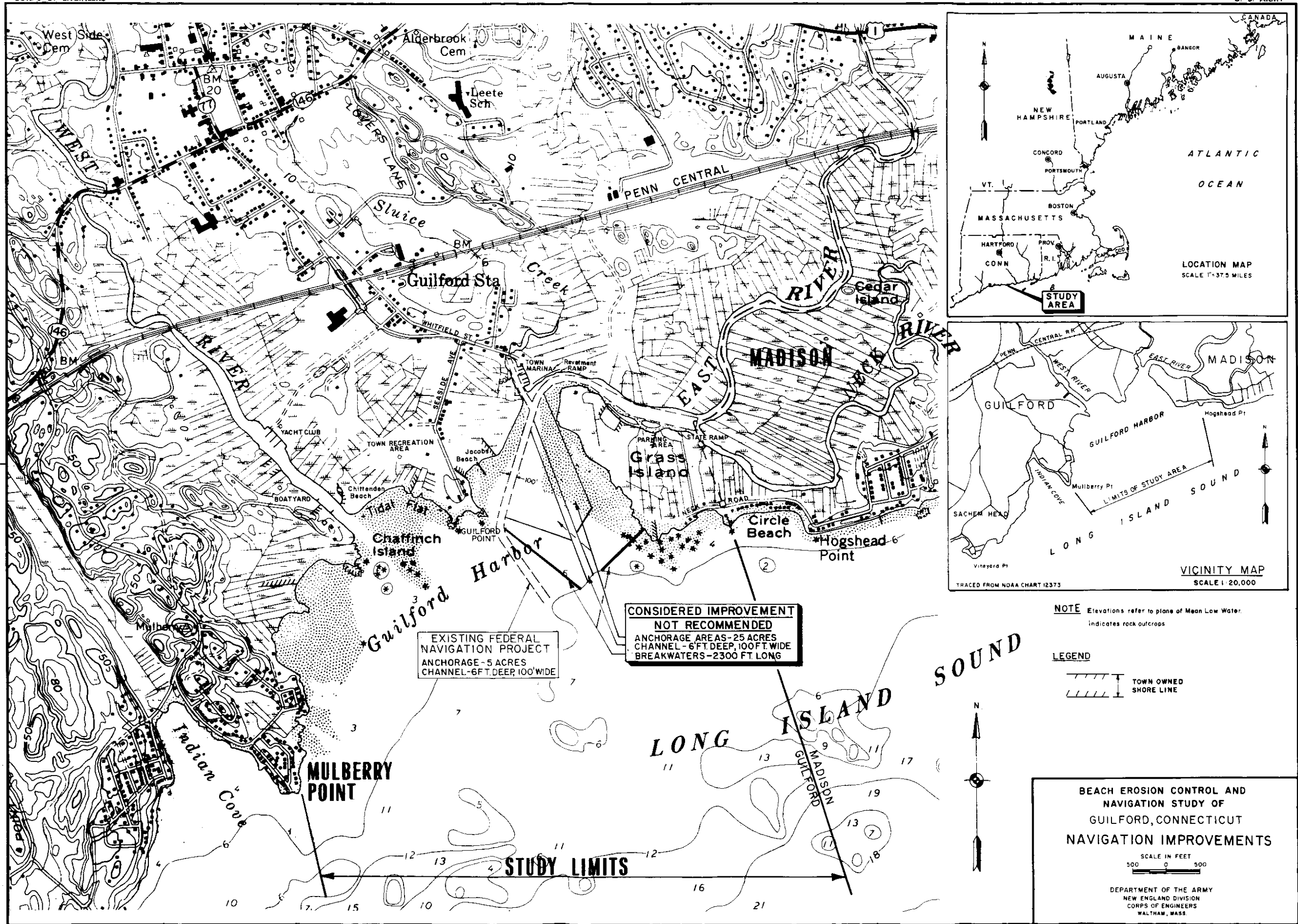
12. Recommendations. Although Federal participation in the desired improvements is not recommended, there are other improvements which could be achieved by local interests such as providing

closer spacing of moorings in the East River anchorage, extension of the Town Marina as proposed, provide additional moorings, particularly fore and aft moorings, in West River including channel dredging of shoal areas. Shore erosion control improvements should be accomplished by filling the gaps between sand dunes fronting marsh areas, followed by planting of grass to stabilize the sandfill, placing sand beside Chaffinch Island, and reinforcing the revetments at the Town Marina and Neck Road.

JOHN H. MASON
Colonel, Corps of Engineers
Division Engineer

3 Incls.

1. Appendix A - Report
2. Senate Resolution 148
3. 8 Plates



NOTE Elevations refer to plane of Mean Low Water.
Indicates rock outcrops

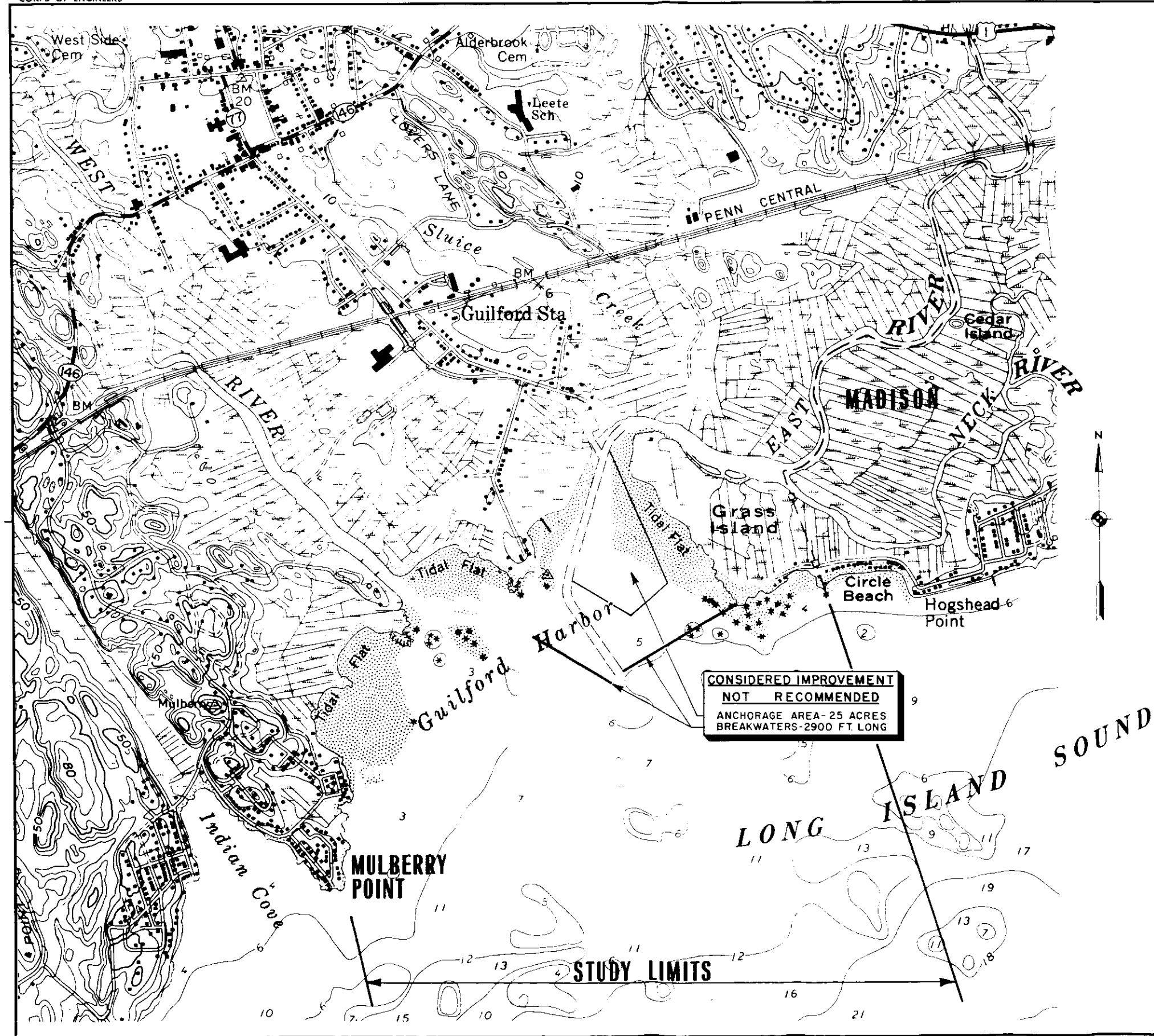
LEGEND

////// TOWN OWNED SHORE LINE

BEACH EROSION CONTROL AND NAVIGATION STUDY OF GUILFORD, CONNECTICUT NAVIGATION IMPROVEMENTS

SCALE IN FEET
500 0 500

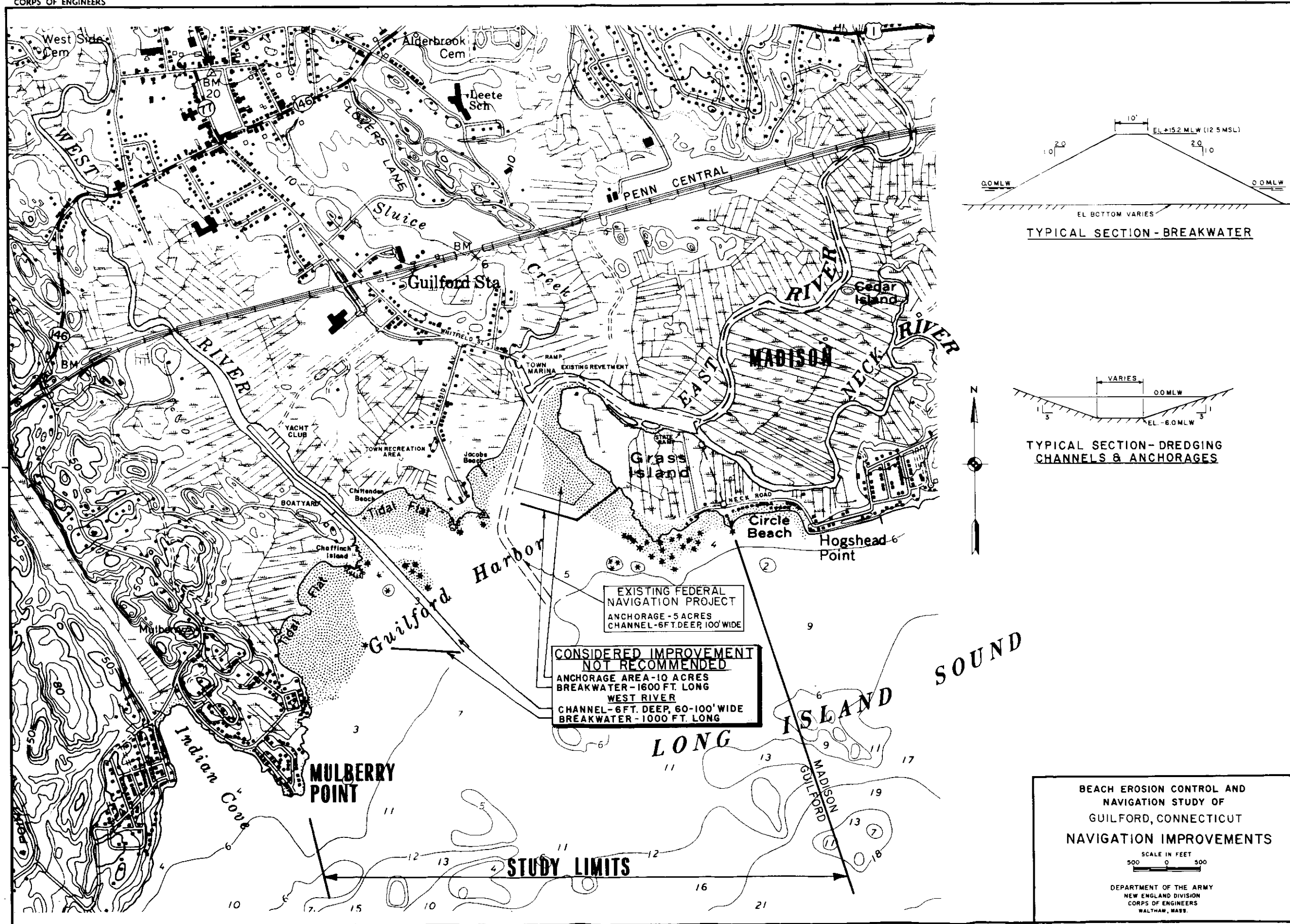
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

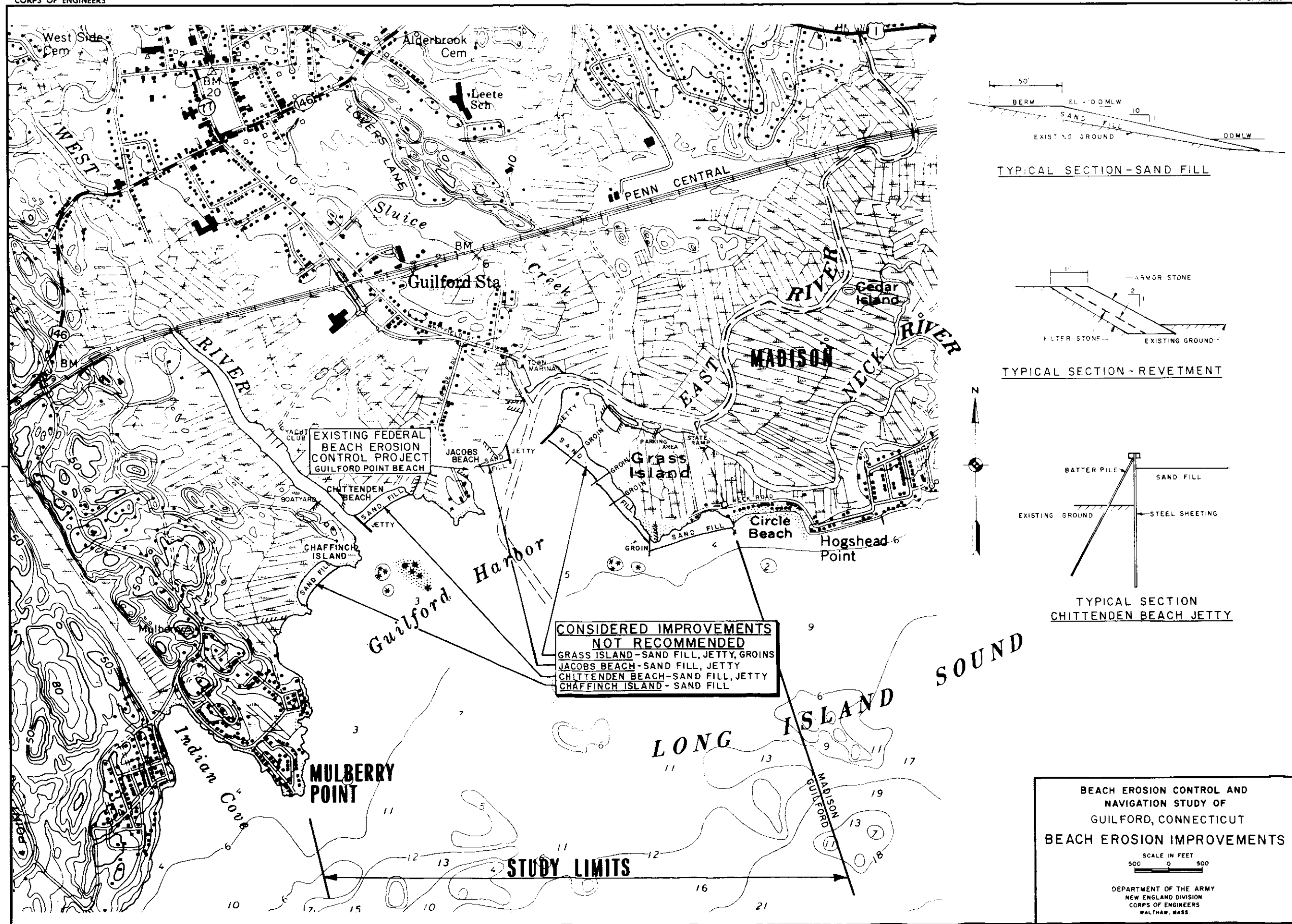


BEACH EROSION CONTROL AND
NAVIGATION STUDY OF
GUILFORD, CONNECTICUT
NAVIGATION IMPROVEMENTS

SCALE IN FEET
500 0 500

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.





APPENDIX A

REPORT

ECONOMIC & ENVIRONMENTAL FEASIBILITY BEACH EROSION CONTROL & NAVIGATION GUILFORD HARBOR, GUILFORD, CONN.

AUTHORITY

The Secretary of the Army has directed the U.S. Army Corps of Engineers to prepare this study under House Resolution dated 2 December 1971 which called for a review of reports on Guilford Harbor as published in House Document No. 149 of the 77th Congress, First Session with a view to modifying the existing project in the interest of navigation and related purposes. The house resolution also called for a survey of the shores of Guilford, Connecticut and adjacent areas, as necessary, in the interest of beach erosion control and related purposes.

The New England Division, Corps of Engineers directed that this study be prepared under Contract No. DA-CW33-74-C-1029.

PURPOSE & SCOPE OF STUDY

The scope of this study involves the economic and environmental feasibility of providing beach erosion control and navigation improvements between the Madison Town Line and Mulberry Point in Guilford. Included in this study were the determination of objectives and concerns of the people involved, the compilation of pertinent data, the analysis of present day conditions, development of possible solutions, the prediction of economic, social, and natural effects of alternative solutions, and recommendations for action.

Prior to the preparation of this study, a hearing was held on August 29th, 1973. Forty-three people attended the hearing. Town Officials and local residents expressed interest in the following improvements: a breakwater and anchorage; a channel in the West River and a jetty at the mouth; the restoration of lost land; the clearance of obstructions in the East Harbor Channel; additional bathing facilities at Chittenden Beach and at Jacobs Beach; improvements to the revetment along the town marina at the entrance to the East River; the reduction of shoaling in Sluice Creek. Interest was also expressed in considering additional shore erosion problems outside the limits of the study area including Indian Cove, Joshua Cove, and Circle Beach in Madison.

GENERAL DESCRIPTION

Guilford is located in the center of the Connecticut Shore line along Long Island Sound. It is about 13 miles east of New Haven and about 17 miles west of the Connecticut River Mouth. (See Plate A-1)

The mean tide range at the site is 5.4 feet. The area is shown on the following maps: The U.S. Geological Survey has published a topographic map, an orthophotoquad, and a surficial geology map of the area, and these maps are identified as the Guilford Quadrangle, and The National Ocean Survey has prepared charts that include the area. These charts include No. 116-SC, No. 217, and No. 1212. The site was included in aerial photography flown for the State of Connecticut Department of Environmental Protection. These include a 1965 flight in which the photographs are at a contact Scale of 1" = 1500'. The site is located on photograph No. 50 of that flight. In 1968, summer photographs at a Scale of 1" = 1000' were flown of the Connecticut shoreline. The area is shown on photograph 14-187. In the 1970 flight of the State of Connecticut also at a Scale of 1" = 1000' the site is shown on photograph 25-517. The site appears on photographs 2903-35-49 and 50 in the color infra-red series taken in July, 1974 (see plates A-2, through A-4) at a Scale of 1" = 1000'. The U.S. Geological Survey had color aerial photographs taken by NASA in 1971 at a Scale of 1" = 4000'. The site is included in that flight.

The site includes the estuaries of West River with a drainage area of 18 sq. miles, Sluice Creek 2.2 sq. miles, the East River 31.6 sq. miles, and the Neck River with a drainage area of 8 sq. miles.

The study area includes the east end of the Guilford shoreline which runs along the south side of the Town. The Town of Guilford is governed by a Board of Selectmen and Town meeting type of Government. The population of the Town is estimated to be 12,700 people (1973). The industries of the Town include agriculture, foundries and manufacturing. Express highway access to the East and to the West for automobiles and trucks is provided by Interstate Route 95, while the Penn Central Railroad provides access for freight to the East and West. Bus service is provided by the Beebe Bus Company in New Haven which is the nearest city to the site.

NAVIGATION-GENERAL

PRIOR REPORTS AND EXISTING PROJECT

In 1941, an investigation of navigation improvements was described in the report contained in House of Representatives Document #149 of the 77th Congress, First Session. That report recommended the construction of a 200' wide anchorage in the East River 6 feet deep at low tide, with a 60 foot channel in Sluice Creek, both to be served by a 100' channel in the outer harbor providing access to deep water. These facilities were completed in 1957. A prior study conducted in 1923 did not produce any recommendations for improvements.

EXISTING SHOREFRONT FACILITIES - GUILFORD HARBOR

The basic navigation facilities consist of sheltered mooring locations, channels, services, conveniences and related activities. (See Plate 2)

Moorings: Existing mooring facilities are grouped primarily in two locations; one the West River and the other the area around the East River. West River mooring facilities include a private Yacht Club, some individual docks, and a few berths at boat yards along the West River. Mooring facilities along the East River areas include private docks along the Neck River, the anchorage at the mouth of the East River and facilities in Sluice Creek. These include the Town Marina, the former State Dock, and a private dock.

Access: Access from the West River to deep water is restricted by a controlling depth of 1' at low water near the mouth of the river. The river itself was dredged in 1971 between the mouth and the Yacht Club by local interests. Access to the East River anchorage in Sluice Creek had been restricted by shoaling of the outer harbor channel to a depth of about 3-1/2 feet prior to maintenance dredging to the design project depth in 1973 and 1974.

Services: There are two public boat launching ramps for general use and for service to the anchorage in the East River. One ramp, operated by the State, is located on Grass Island, accessible by way of Madison. The other ramp is provided by the Town on the north side of the East River at the Town Marina. Fuel is provided at the head of Sluice Creek. The Town Marina also provides parking, toilets and a Coast Guard Auxiliary Station.

There are two boat yards located on the West River to provide service and storage for boats. One is located near the mouth. The other is north of the railroad bridge. A marine hardware store is located about 1/2 mile inland.

Convenience and Related Activities: The Town Marina has a few picnic tables. There are two restaurants located adjacent to the Town Marina as well as a fish market. There is a sail maker and a marine equipment manufacturer 1/2 mile inland.

NEARBY HARBORS

The adjacent harbors are located in Branford and Clinton, about 7 & 8 miles west and east of Guilford Harbor.

Branford Harbor has a design depth of 8', but is sometimes shoaled to a depth of 5'. There are several marinas which appear fully utilized. Near the easterly end of the Branford shoreline at Stony Creek there is a small harbor. Clinton Harbor has a design depth of 8' but sometimes shoals to 4'. The marinas in Clinton Harbor also appear full.

COMMERCIAL AND RECREATIONAL VESSEL TRAFFIC

Present use of the harbor includes some commercial fishing but mostly recreational boating.

Commercial Fishing: Lobsters, bait fish and oysters are brought in by a few commercial boats and several part-time fishermen. Recent production has been reported at 3000 tons of shellfish a year.

Recreational Boating: There are about 150 boats moored in the East River area. About 120 of these are located in Sluice Creek. There are a few in the anchorage and a few in the Neck River. Some additional small boats are brought in to use the area by way of the boat launching ramps.

There are about 80 boats berthed in the West River, mostly at the Yacht Club, with a few individual docks and a few boats moored at the boat yard.

DIFFICULTIES ATTENDING NAVIGATION AND IMPROVEMENTS DESIRED

There is a need for more space to moor boats, and there is a need for a deeper access from the West River to deep water.

Moorings: There are many people looking for mooring space. The Town Marina has a waiting list of 50 people. They estimate that they have received inquiries from another 120 people. There are about 800 boats registered in the Town of Guilford. Visitors have had difficulty mooring their boats to eat at the restaurants at Sluice Creek. The demand for mooring areas should increase.

Sluice Creek is subject to rapid shoaling to a depth of about 1' in spots. This shoaling is probably caused by material from the face of Grass Island and from the floor of the harbor placed in suspension by waves and then washed into the creek.

Mooring facilities in the East River anchorage are severely limited since only one row of boats can be placed along each side of the channel which provides access to the State boat launching ramp and to the Neck River. At present these moorings along the anchorage are spaced far apart.

The channel in the East River anchorage area stays deep while the sides shoal to reduce the width to about 150' at a 3' depth. This narrowing does not seem to restrict the number of boats that can be moored in the anchorage.

Access: The West River shallow entrance depth severely restricts the use of the river which is the only site for a significant potential increase in navigation facilities, especially for deep draft boats. If a deep channel could be opened and kept open, the West River could be utilized more efficiently.

MOORING NEEDS

Possible Alternatives: The response to this problem can involve no action, local improvements, or Federal Improvements.

If no added mooring facilities are provided, a recreational boating demand will go unfulfilled.

Property owners have very little space available for expansion of mooring facilities. Most undeveloped land in the area has been designated tidal wetlands by the State Department of Environmental Protection. It is not possible to predict whether or not the Department would authorize the filling or dredging of any of these tidal wetlands. There are only two small areas that have not been so designated. These are both former spoil areas where material has been deposited from past dredging projects. One is on private property northeast of the Town Marina. If this area can be utilized for parking, then the Town Marina berths could be expanded into the present marina parking area. The Town is considering this possibility. The other available site is on the Yacht Club property on the West River. This area is being considered as a site for adding a new marina. On the west bank of the West River adjacent to the existing yard, there is a small area being considered for the establishment of an additional boat yard.

Some additional mooring capacity might be provided in the East River anchorage by placing the moorings closer together, possibly using piles as in Branford Harbor.

If the mouth of the East River could be relocated to the south, more area would be available for expansion of the Town Marina. Although the tip of Grass Island is designated as a tidal wetland, it is not a salt marsh, but is rather high, sandy ground. However, such a project does not appear feasible.

There are two spoil areas that have been designated as tidal wetlands. One is in the middle of Grass Island, and the other is on private property east of Jacobs Beach. These sites also do not appear to be practicable for additional mooring facilities.

The only means available for the U.S. Army Engineers to provide additional mooring capacity would be by the creation of an anchorage in the outer harbor, to be serviced by the Town Marina. This area is exposed to wave attack from the Sound and would have to be protected from such wave attack in order for an anchorage to be safe.

ANCHORAGE ALTERNATIVES

FUNCTIONAL & ENVIRONMENTAL DESIGN FACTORS:

Functional Requirements: For effective boat usage, it will be necessary that an anchorage will be convenient to marina facilities. It will also require a continued safe access to deep water with an adequate depth. Sufficient room will be needed for safe maneuvering between boats. Breakwaters will be required to protect the boats from storm damage. If the breakwaters are constructed with the top elevation at 12-1/2 feet above mean sea level, this will prevent wave overtopping except in occasional severe storms. This would occur at a spring tide elevation of 6.4 feet with a 3-foot storm surge and a 6-foot wave. Breakwaters would have a top width of 10 feet and 2-1 side slopes with stones large enough to be stable under wave attack.

Environmental Design Factors: If breakwater stone were transported to the site by land, it would be necessary to assure that this would not cause problems through traffic or excessive pavement loading on the access roads, or through damage to marshland between the roads and the breakwater. It would also be necessary to assure that no contamination resulted from dredging operations either in the original excavation or in later maintenance dredging. This contamination would have to be prevented in the excavation of the material, the transporting of the material, and the deposition at the spoil site, either on land or at offshore dumping grounds. It would also be necessary to assure that there would be no damage from oil or waste discharges from the use of the boats. Boating traffic would have to be controlled to avoid hazards to bathers. Adequate Town facilities would be required including sufficient access road capacity to handle the traffic load. This would be especially significant in the center of Town and in the vicinity of the Town Marina.

Also, the Town would have to provide parking, policing of boat traffic, ferry service to the Marina, sanitary facilities, fuel facilities, a landing for dingies, and facilities for storage of dingies. It would be necessary to assure that any significant shell fish potential was not damaged by the facilities. It would be necessary to avoid disturbance of aesthetic features such as scenic seascapes or quiet settings. Environmental changes resulting from the creation of an anchorage would include the stimulation of related marine commercial activities and the elimination of the encroachment of the tip of Grass Island into the mouth of the East River.

ALTERNATIVE SOLUTIONS

Three anchorage configurations were considered. One is a small anchorage at the mouth of the East River. The other two are larger anchorages with breakwaters extending out to the mouth of the channel; one using the existing channel, the other involving the relocation of the channel.

SMALL ANCHORAGE

This plan consists of a 10-acre anchorage south of the channel protected by a breakwater extending from the channel to Grass Island. (See Plate A-2)

This anchorage would be close to the Marina. The existing channel would be utilized for access to deep water so that this access would be subject to the shoaling problem that presently exists in the channel. This smaller anchorage would require fewer services for Town facilities and the traffic load would be lighter than for the larger anchorage. This anchorage would have a capacity for fewer boats but the protective breakwater, being located in shallower water, would be less expensive per foot.

Economic Benefits: The basic analysis factors that were used for the determination of economic benefits are included in Appendix AA. This particular anchorage also is based on the assumption that the anchorage would be filled from the first year, since the capacity of 130 boats is less than the 170 boats which have been indicated by the Town as being interested in mooring space. It was also assumed that the shoaling problem in the access channel would be eliminated so that this would not limit the full utilization of the anchorage. The determination of the annual benefits derived from this plan shown in Table 1 indicates an annual benefit of \$87,000.

TABLE I. BENEFITS TO RECREATIONAL BOATING

NEW BOATS

HARBOR: SMALL ANCHORAGE GUILFORD HARBOR

BOATING SEASON 160 DAYS

RECREATIONAL FLEET												
TYPE OF CRAFT	LENGTH (feet)	# of Boats	DEPRECIATED VALUE		PERCENT RETURN				VALUE \$	ON CRUISE		Value \$
			Average \$	Total \$	Ideal	% of Ideal	Gain	Avg. % of Days		Season		
RECREATIONAL FLEET												
Outboards	15-20	68	3,400	231,200	14	0	95	13.3	30,749.60			
	21&Up		5,150									
Sterndrive	15-20	8	4,750	38,000	12	0	95	11	4,180.00			
	21-25	6	6,850	41,100	11	0	95	10	4,110.00			
	26&Up	1	14,300	14,300	10	0	95	9	1,287.00			
Inboards	15-20	7	4,950	34,650	12	0	95	11	3,811.50			
	21-30	14	10,400	145,600	11	0	95	10	14,560.00	14	9	1,310.40
	31-40	4	28,500	114,000	10	0	95	9	10,260.00	19	12	1,231.20
	41-50	3	64,200	192,600	8	0	95	8	15,408.00	32	20	3,081.60
	51-Up		166,800									
Cruising	15-20	4	4,500	18,000	9	0	95	9	1,620.00			
Sailboats (Auxiliary)	21-30	4	9,450	37,800	8	0	95	8	3,024.00	8	5	151.20
	31-40		28,750									
	41&Up		61,150									
Daysailers	8-15	4	1,600	6,400	12	0	95	11	704.00			
	16-20	5	2,850	14,250	12	0	95	11	1,567.50			
	21-25	3	5,100	15,300	11	0	95	10	1,530.00			
	26&Up		5,350									

TOTALS

130

\$92,811.60

\$5,774.40

\$92,811.60

-5,774.40

ANNUAL BENEFITS - \$87,037.20

A-8

Costs: The estimation of costs for this alternative is based on the analysis factors that are described in Appendix AA. Table 2 shows the derivation of the cost estimate for this alternative. This shows an annual cost of \$149,300.

TABLE II
SMALL ANCHORAGE COSTS

	Anchorage Dredging	Breakwater
Volume	101,000 cu. yd.	27,900 cu.yd.
Unit Price	\$3.75 per cu. yd.	\$36 per cu. yd.
Basic Cost	\$378,750	\$1,004,400
Contingencies (15%)	56,812	150,660
Construction	\$435,562	\$1,155,060
Engineering & Design (8%)	34,845	(7%) 80,854
Supervision & Admin. (7%)	30,489	80,854
First Cost	\$500,896	\$1,316,768
Amortization (.00330)	1,653	4,345 per yr.
Interest (6-1/8%)	30,680	80,652 per yr.
Amortization & Interest	\$32,333	\$84,997 per yr.
Maintenance	20,000	(1%) 12,000 per yr.
Annual Cost	\$52,333	\$96,997 per yr.

Total Annual Cost - \$149,330 per year

Benefit Cost Ratio: The benefit cost ratio of 0.58 to 1 indicates that there are not sufficient benefits to justify the cost of this improvement.

LARGE ANCHORAGE - EXISTING CHANNEL

This alternative includes a breakwater from the tip of Grass Island to the outer end of the existing channel as well as another breakwater from the channel end to the vicinity of Guilford Point. (See Plate A-3) The breakwaters would protect a 25-acre anchorage. In comparison to the smaller anchorage, it would require that some of the boats would be more remote from the land side facilities. The breakwaters would protect the harbor from wave action and would not only reduce the channel shoaling but also reduce the disturbance of material which washes into Sluice Creek. The breakwaters are located to intercept all waves from offshore except that there would still be some wave action within the anchorage area from those waves passing through the opening in the breakwater at the end of the channel. These waves would be diffracted to some extent. This alternative involves a larger volume of excavation, and the location of a suitable disposal site would be a greater problem. The breakwaters would be much longer, and, because of the greater depths, they would be more expensive per foot than those for the smaller anchorage.

Economic Benefits: In addition to the general factors in Appendix AA, this analysis is also based on the anticipation of 170 boats using the anchorage from the first year with the remainder of the boats growing to fill the anchorage in 50 years, with a faster growth in the earlier period. Erosion control benefits are based on the control of the loss of the salt marsh areas behind the breakwaters.

Table 3 shows the determination of the benefits derived for recreational boats starting in the first year. Table 4 shows the benefits derived from the additional boats coming into the anchorage over the 50 year life of the project. The benefits are \$109,700 and \$62,400 respectively, giving a total recreational boating benefit of \$172,100 per year.

The breakwaters would reduce the erosion of the marshland along the shore of Grass Island and east of Jacobs Beach. This would constitute about 3,000 feet of shoreline. Assuming that this shoreline would be subject to erosion at a rate of 2-1/2 ft. a year and assuming the value of \$500 per acre for marshland, the benefit for the elimination of this erosion would be approximately \$100 per year.

TABLE III. BENEFITS TO RECREATIONAL BOATING

NEW BOATS - IMMEDIATELY ADDED

HARBOR: GUILFORD HARBOR LARGE ANCHORAGE

BOATING SEASON 160 DAYS

A-11

TYPE OF CRAFT		LENGTH (feet)	# of Boats	DEPRECIATED VALUE		PERCENT RETURN				VALUE \$	ON CRUISE		Value \$
				Average \$	Total \$	Ideal	% of Ideal	Gain			Avg. % of Days	Season	
						Pres.	Fut.						
RECREATIONAL FLEET													
Outboards	15-20	87		3,400	295,800	14	0	95	13	38,454.00			
	21&Up			5,150									
Sterndrive	15-20	10		4,750	47,500	12	0	95	11	5,225.00			
	21-25	9		6,850	61,650	11	0	95	10	6,165.00			
	26&Up	2		14,300	28,600	10	0	95	9	2,574.00			
Inboards	15-20	10		4,950	49,500	12	0	95	11	5,445.00			
	21-30	19		10,400	197,600	11	0	95	10	19,760.00	14	9	1,778.40
	31-40	5		28,500	142,500	10	0	95	9	12,825.00	19	12	1,539.00
	41-50	3		64,200	192,600	8	0	95	8	15,408.00	32	20	3,081.60
	51-Up			166,800									
Cruising	15-20	5		4,500	22,500	9	0	95	9	2,025.00			
Sailboats (Auxiliary)	21-30	5		9,450	47,250	8	0	95	8	3,780.00	8	5	189.00
	31-40			28,750									
	41&Up			61,150									
Daysailers	8-15	5		1,600	8,000	12	0	95	11	880.00			
	16-20	7		2,850	19,950	12	0	95	11	2,194.50			
	21-25	3		5,100	15,300	11	0	95	10	1,530.00			
	26&Up			5,350									

TOTALS

170

\$116,265.00

\$6,588.00

\$116,265.50

- 6,588.00

ANNUAL BENEFIT-\$109,677.50

TABLE IV. BENEFITS TO RECREATIONAL BOATING

NEW BOATS - GRADUAL GROWTH

HARBOR: GUILFORD HARBOR, LARGE ANCHORAGE

BOATING SEASON 160 DAYS

TYPE OF CRAFT					LENGTH (feet)		# of Boats	DEPRECIATED VALUE		PERCENT RETURN				VALUE \$	ON CRUISE		Value \$
								Average \$	Total \$	Ideal	% of Ideal	Gain			Avg. % of Days	Season	
										Pres.	Fut.						
RECREATIONAL FLEET																	
Outboards		15-20	79	3,400	268,600	14	0	95	13				34,918.00				
		21&Up		5,150													
Sterndrive		15-20	9	4,750	42,750	12	0	95	11				4,702.50				
		21-25	8	6,850	54,800	11	0	95	10				5,480.00				
		26&Up	2	14,300	28,600	10	0	95	9				2,574.00				
Inboards		15-20	9	4,950	44,550	12	0	95	11				4,900.50				
		21-30	16	10,400	166,400	11	0	95	10				16,640.00	14	9		1,497.60
		31-40	5	28,500	142,500	10	0	95	9				12,825.00	19	12		1,539.00
		41-50	3	64,200	192,600	8	0	95	8				15,408.00	32	20		3,081.60
		51-Up		166,800													
Cruising		15-20	5	4,500	22,500	9	0	95	9				2,025.00				
Sailboats		21-30	5	9,450	47,250	8	0	95	8				3,780.00	8	5		189.00
(Auxiliary)		31-40		28,750													
		41&Up		61,150													
Daysailers		8-15	5	1,600	8,000	12	0	95	11				880.00				
		16-20	6	2,850	17,100	12	0	95	11				1,881.00				
		21-25	3	5,100	15,300	11	0	95	10				1,530.00				
		26&Up		5,350													

TOTALS

155

\$107,544.00

\$6,307.20

\$107,544.00

- 6,307.20

Net Peak Year Benefit - \$101,236.80

50 Yr. Accelerated Growth Factor x 0.616

EQUIVALENT ANNUAL BENEFIT - \$ 62,361.87

The breakwaters would also reduce the cost of the maintenance of the existing channel. It was assumed that the channel would have to be dredged every five years in order to keep it reasonably effective. The cost of this dredging is indicated on Table 5. The reduction of these maintenance costs to a reasonable level would result in an annual benefit of approximately \$22,700.

The total benefits for this alternative include recreational boating benefits of \$172,700 per year, reduced maintenance of \$22,600 per year, and erosion protection of \$100 per year, providing a total benefit of \$195,400 per year.

TABLE V

MAINTENANCE DREDGING COSTS

EXISTING CHANNEL

WITHOUT PROTECTION - Complete redredging every 5 years

29,300 cu. yd. @ \$3.75 per cu. yd.	\$110,000
Contingencies (15%)	<u>16,500</u>
Construction Costs	\$126,500
Engineering & Design (5%)	6,300
Supervision & Admin. (7%)	<u>8,900</u>
First Cost of Each Redredging	\$141,700
Annual Cost, Interest & Amortization (Amortized at 6-1/8%) (\$141,700 x 0.17690)	\$ 25,100 per year

PROTECTED BY BREAKWATERS

(10% of channel each 5 years)	\$ 2,510 per year
Difference -	\$22,590 per year

Cost Estimate: The costs for this work are based on the general analysis factors described in Appendix AA. The determination of these costs is described on Table 6. The total annual cost of this alternative is \$405,600.

TABLE VI
LARGE ANCHORAGE COSTS
EXISTING CHANNEL

	<u>Anchorage Dredging</u>	<u>Breakwater</u>
Volume	300,000 cu. yd.	79,700 cu.yd.
Unit Price	\$3.75 per cu.yd.	\$36 per cu.yd.
Basic Cost	\$1,125,000	\$2,869,200
Contingencies (15%)	<u>168,750</u>	<u>430,380</u>
Construction	\$1,293,750	\$3,299,580
Engineering & Design (7%)	90,562	(7%) 230,970
Supervision & Admin. (7%)	<u>90,562</u>	<u>230,970</u>
First Cost	\$1,474,875	\$3,761,521
Amortization (.00330)	4,867 per yr.	12,413 per yr.
Interest (6-1/8%)	<u>90,336 per yr.</u>	<u>230,393 per yr.</u>
Amortization & Interest	\$95,203	\$242,806 per yr.
Maintenance (2%)	<u>30,000</u>	(1%) <u>37,600</u>
Annual Cost	\$125,203 per yr.	\$280,406 per yr.

Total Annual Cost - \$405,609 per yr.

Benefit Cost Ratio: The total annual benefits of \$195,400 per year and the annual cost of \$405,600 per year produce a benefit cost ratio of 0.48 to 1 for the large anchorage using the existing channel. This indicates that the benefits do not justify the cost of such a project.

LARGE ANCHORAGE - RELOCATED CHANNEL

A relocated channel was considered as an alternative to leaving the channel in its existing location. This would allow the construction of shorter breakwaters and would also bring the navigation facilities farther away from Jacobs Beach, reducing conflict between the use of the two facilities and providing room for the possible expansion of Jacobs Beach. The barrier adjacent to Grass Island might be constructed of earth as a land extension instead of using a stone breakwater.

The economic benefits of this alternative are the same as those for the large anchorage with the existing channel, amounting to \$195,400. Table 7 describes the cost of the construction of this alternative, giving a total cost of \$350,500 a year. This only increases the benefit cost ratio to 0.56 to 1.

TABLE VII

COSTS

LARGE ANCHORAGE

RELOCATED CHANNEL

	<u>Dredging</u>	<u>Breakwaters</u>
Volume	350,000 cu. yd.	58,100 cu.yd.
Unit Price	\$3.75 per cu.yd.	\$36 per cu.yd.
Basic Cost	\$1,312,500	\$2,091,600
Contingencies (15%)	196,875	313,740
Construction	\$1,509,375	\$2,405,340
Engineering & Design (7%)	105,656	168,373
Supervision & Admin. (7%)	105,656	168,373
First Cost	\$1,720,687	\$2,742,087
Amortization (.00330)	5,678 per yr.	9,049 per yr.
Interest (6-1/8%)	105,392 per yr.	167,953 per yr.
Amortization & Interest	\$111,070 Per yr.	\$177,002 per yr.
Maintenance	(2%) 35,000 "	(1%) 27,400 per yr.
Annual Cost	\$146,070 per yr.	\$204,402 per yr.

Total Annual Cost - \$350,472 per year.

WEST RIVER CHANNEL

POSSIBLE ACTION

If no action is taken, then the shallow depth in the mouth of the river will restrict the use of deep draft boats. The solution would be to dredge a channel and keep the channel open, either by local interests or as a Federal project.

FUNCTIONAL & ENVIRONMENTAL DESIGN FACTORS

The Corps of Engineers could dredge a channel to a public landing. The channel would require adequate depth, a safe width, and stable slopes with minimum contortions. This would call for a 6 ft. channel, 60 ft. wide through the river, and 100 ft. wide in the open harbor, running straight from the mouth of the river to the 6 ft. depth. It is assumed that the public landing would be established north of the existing yacht club on the east bank of the West River. (See Plate A-3)

Because of the rapid shoaling characteristics of Guilford Harbor, the channel would be subject to frequent maintenance dredging if it is not protected from wave action by breakwaters.

Environmental design factors include the requirement that the dredging operations prevent any harmful contamination of the waters from the excavation, transportation or deposition of materials both in the initial dredging and the maintenance dredging.

CHANNEL WITHOUT BREAKWATERS

It is assumed that the channel would be maintained every five years in order to provide a depth adequate for reasonable utilization of the channel.

Estimate of Benefits: It is assumed that the facilities in the West River would be expanded to the maximum boat mooring capacity regardless of whether the channel is dredged or not. It is assumed that boats with drafts of 3 or 4 feet would not utilize the river if it were not dredged. It was assumed that 114 boats would be added to the existing 69 boats in the West River facilities. It was assumed that the distribution of boat sizes would be the same as for the anchorage. Table 8 shows the benefits that would be gained from the existing fleet. The benefits from new boats are shown on Table 9. The total benefits would be \$26,500 a year.

TABLE VIII. BENEFITS TO RECREATIONAL BOATING

EXISTING FLEET

HARBOR: WEST RIVER

BOATING SEASON 160 DAYS

A-17

TYPE OF CRAFT	LENGTH (feet)	# of Boats	DEPRECIATED VALUE		PERCENT RETURN				VALUE \$	ON CRUISE		Value \$
			Average \$	Total \$	Ideal %	% of Ideal	Gain	Avg. % of Days		Season		
RECREATIONAL FLEET												
Outboards	15-20	13	3,400	44,200	14	100	100	0				
	21&Up		5,150									
Sterndrive	15-20	7	4,750	33,250	12	72	95	3	997.50			
	21-25	8	6,850	54,800	11	72	95	3	1,644.00			
	26&Up		14,300		10							
Inboards	15-20	5	4,950	24,750	12	72	95	3	742.50			
	21-30	9	10,400	93,600	11	72	95	3	2,808.00	14	9	252.72
	31-40	2	28,500	57,000	10	58	85	3	1,710.00	19	12	205.20
	41-50		64,200		8							
	51-Up		166,800									
Cruising	15-20		4,500		9							
Sailboats (Auxiliary)	21-30	3	9,450	28,350	8	58	85	2	567.00	8	5	28.35
	31-40	2	28,750	57,500	7	47	75	2	1,150.00	8	5	57.50
	41&Up		61,150									
Daysailers	8-15	9	1,600	14,400	12	72	95	3	432.00			
	16-20	8	2,850	22,800	12	72	95	3	684.00			
	21-25	3	5,100	15,300	11	58	85	3	459.00			
	26&Up		5,350									
TOTALS		69							\$11,194.00			\$543.77

\$11,194.00

- 543.77

ANNUAL BENEFIT - \$10,650.23

TABLE IX. BENEFITS TO RECREATIONAL BOATING

NEW BOATS

HARBOR: WEST RIVER

BOATING SEASON 160 DAYS

NEWPORT WEST RIVER												
TYPE OF CRAFT	LENGTH (feet)	# of Boats	DEPRECIATED VALUE		PERCENT RETURN				VALUE \$	ON CRUISE		Value \$
			Average \$	Total \$	Ideal	% of Ideal	Gain	Avg. % of Days		Season		
RECREATIONAL FLEET												
Outboards	15-20	85	3,400	289,000	14	100	100	0	0			
	21&Up		5,150									
Sterndrive	15-20	4	4,750	19,000	12	72	95	3	570.00			
	21-25		6,850		11							
	26&Up	3	14,300	42,900	10	0	85	9	3,861.00			
Inboards	15-20	5	4,950	24,750	12	72	95	3	742.50			
	21-30	9	10,400	93,600	11	72	95	3	2,808.00	14	9	252.72
	31-40	1	28,500	28,500	10	0	85	9	2,565.00	19	12	307.80
	41-50	4	64,200	256,800	8	0	75	2	5,136.00	32	20	1,027.20
	51-Up		166,800									
Cruising Sailboats (Auxiliary)	15-20		4,500		9							
	21-30	2	9,450	18,900	8	0	85	7	1,323.00	8	5	66.15
	31-40		28,750		7							
	41&Up		61,150									
Daysailers	8-15		1,600		12							
	16-20		2,850		12							
	21-25	1	5,100	5,100	11	0	85	9	459.00			
	26&Up		5,350									

TOTALS

114

\$17,464.50

\$1,653.87

\$17,464.50

- 1,653.87

ANNUAL BENEFIT - \$15,810.63

Cost Estimate: The cost of the channel dredging project is based on complete redredging at 5-year intervals. The determination of the costs is shown on Table 10. The annual cost of \$72,900 includes \$55,900 a year for maintenance dredging.

TABLE X

COSTS

WEST RIVER DREDGING

	Channel Dredging	Maintenance Dredging (5 yr.)
Volume	53,100 cu.yd.	63,700 cu.yd.
Unit Price	\$3.75 per cu.yd.	\$3.75 per cu.yd.
Basic Cost	\$199,125	\$238,875
Contingencies (15%)	29,868	35,831
Construction	\$228,993	\$274,706
Engineering & Design (8%)	18,319	(8%) 21,976
Supervision & Admin. (7%)	16,029	19,229
First Cost	\$263,342	\$315,912
Amortization (.00330)	869/yr.	
Interest (6-1/8%)	16,130/yr.	
Amortization & Interest	\$16,999/yr.	
Maintenance (315,912 x 0.1769)	55,885/yr.	
Annual Cost	\$72,884/yr.	

Benefit Cost Ratio: The benefit cost ratio for such a project would be 0.36 to 1.

BREAKWATERS

The maintenance cost could be reduced considerably by protection from breakwaters. However, such breakwaters would cost at least \$120,000 a year and this would far exceed the maintenance dredging cost that would be reduced.

SUGGESTIONS - NAVIGATION

No economic justification was found for any navigation improvements. However, the town plan to expand the Town Marina will help, as would any marina development of available areas in the West River. Closer spacing of boats in the East River would provide some more boat capacity. Local efforts to dredge the West River would improve access.

BEACH EROSION CONTROL

PRIOR REPORTS & EXISTING PROJECT

The westerly portion of the area up to the East River, was contained in the report titled "Beach Erosion Control Report on the Cooperative Study of Connecticut, Area 9, East River to New Haven Harbor", prepared by the Corps of Engineers, U.S. Army, New England Division on August 15th, 1955. The area from the East River to Madison was contained in the similar report for Area 2, entitled "Hammonasset River to East River", dated February 7, 1949. The Area 9 report recommended the construction of a groin at Jacobs Beach, east of Guilford Point with Federal participation, and also recommended placement of sandfill at Jacobs Beach by local interests. The groin was constructed in September, 1957 and the sandfill was placed in September of 1959. (See Plate A-4)

DESCRIPTION OF SHORELINE

Houses are located along the shoreline at Mulberry Point, Guilford Point and a few houses on Grass Island. Town shoreline recreational facilities include a picnic area at Chaffinch Island, bathing at Jacobs Beach, and boating at the Town Marina at Sluice Creek. The remainder of the shoreline consists of salt marshes including Grass Island and bights located between rocky headlands. Most of these salt marshes are owned by the Town for preservation and nature study.

Some parts of the shoreline are stable because they consist of materials that are resistant to wave attack or because they have a sand blanket that is adequately contained from being washed away. The erosion resistant materials, such as ledges, seawalls, bulkheads and revetments protect residential property along Mulberry Point, Guilford Point and on Grass Island. They also protect the Town property at Chaffinch Island, at the marina, and along Neck Road from Madison to Grass Island. The sand blanket on Jacobs Beach is contained on the west by Guilford Point and on the east by a groin, and is contained at the back by high ground. Surveys over a nine year period show Jacobs Beach to be essentially unchanged.

STATEMENT OF PROBLEM AND IMPROVEMENTS DESIRED

Shore Erosion: The salt marsh areas have been receding at a rate of 2-1/2 feet per year as indicated by comparative shoreline surveys over the 100 years as reported in the Beach Erosion Control Area Reports for the area. It is desired to stabilize the shoreline along these marsh areas. The revetment along the face of the Town Marina is subject to damage and overtopping and should be strengthened. The revetment along Neck Road at Grass Island might also need to be strengthened to protect the road.

Existing Bathing Facilities: The beaches in the area include one major state park and a few small town beaches. Hammonasset State Park in Madison has a capacity of about 30,000 people based on the available parking capacity. The Town of Guilford has bathing areas at Jacobs Beach as well as two small areas at Lake Quonopaug, 7 miles north of the center of Town. Jacobs Beach can accommodate approximately 600 people without crowding. The offshore area is very shallow and interferes with swimming at low tide. This area was dug out but has filled in again. Because of this condition, the beach is generally used only once a day during the higher portion of the tide cycle. Beach use is also reduced by the presence of jellyfish early in August.

Hammonasset Beach is representative of the beach use in the region. In 1972, daily attendance figures indicate that the beach was filled to the capacity of 30,000 people twice during the year. Crowded conditions are reached at an attendance of about 20,000 people. This condition occurred ten times during that year. Over the recorded 153-day season, the average attendance was about 4,000 people.

At Jacobs Beach, daily car counts during the 1974 bathing season indicate that on weekends the capacity of 600 people was reached on one day. The average weekend attendance was 170 people per day for the 24 weekend days in the season. This represents about 28% of the capacity.

Swimming classes held on week days use about 1/4 of the beach, reducing the capacity to 450 other bathers. This capacity was reached twice during the season. The average attendance over the 40 week days in the season was 160 people per day or 36% of the available capacity. The beach was not used on 7 additional days of the 71 days of school vacation when car counts were recorded. There were no records kept except during that period.

Population projections indicate that beach crowding will increase over the next 50 years. A 100% increase in population over a 50-year period was assumed for estimating an extreme condition.¹ In this case, Hammonasset Beach would be filled 14 days during that 50th year. At Jacobs Beach it was assumed that the class usage would also double, leaving 1/2 of the beach available for general bathing on week days. It was estimated that the beach would then be filled on 22 week days and 5 week-end days in the 50th year. The capacity of Jacobs Beach would be exceeded by 600 additional people on two days during that year.

1. See Appendix AA

METHODS OF CORRECTING EROSION PROBLEMS

Additional loss of land could be reduced by the containment of sand along the marsh areas west of Chaffinch Island, at Chittenden Beach, the area adjacent to Jacobs Beach, and the south face of Grass Island.

The placement of a barrier such as a jetty or a groin at the end of Chittenden Beach, or at the end of the south face of Grass Island would serve to contain these beaches at the ends. Such containment would be a problem at the area adjacent to Jacobs Beach because a stable shoreline would have to face the direction of wave attack. This would be essentially parallel to Jacobs Beach and would require a great change. Along the west face of Grass Island, stable beaches would be at an extreme angle to the present shoreline. The shore would have to be broken into several sections with many groins holding each short stretch of shoreline in stable alinement. (See Plate A-4)

If any of the shoreline areas could be protected from wave attack by the placement of a barrier such as a breakwater, this would reduce the erosion. Any eroding area could also be protected through stabilization with revetments, seawalls, or similar structures.

Such jettys, groins or breakwaters would also serve to reduce shoaling of the channels.

MARSH STABILIZATION IMPROVEMENTS CONSIDERED

Functional & Environmental Design Factors: Revetment protection was selected for economic evaluation as a representative means of stabilizing the eroding marsh shorelines. A typical revetment would be approximately 10' high with a 2 to 1 slope and about 5' thick constructed of stone. The toe would be embedded to prevent undermining. It is assumed that there would be stone available and that foundation conditions would be adequate to support these revetments. Design criteria are described in Appendix AA.

Any revetment would have to be constructed to minimize disturbance of the marsh, both during construction and for long term drainage.

Economics: Any measure that would prevent further erosion of the salt marshes would provide an annual benefit of \$.03 per foot based on anticipated continued erosion at a rate of 2-1/2 feet a year and land value of \$500 an acre for marshland.

Revetment costs per foot are shown in Table XI and are \$18 per foot. This is extremely high compared to the benefit of \$0.03 per year. The other methods of stabilization would be similarly expensive.

TABLE XI

REVTMENT COST PER FOOT

Volume	4.98 cu. yd./l.f
Unit Price	\$36 per cu. yd.
Basic Cost	\$179.28
Contingencies (15%)	26.89
Construction	\$206.17
Engineering & Design (8%)	16.49
Supervision & Admin. (7%)	14.43
First Cost	\$237.09
Amortization (.00330)	0.78 per year
Interest (6-1/8%)	14.52 per year
Amortization & Interest	\$15.30 per year
Maintenance (1%)	2.50 per year
Total Annual Cost	\$17.80 per year/l.f.

BATHING BEACH IMPROVEMENTS CONSIDERED

Additional beaches would serve to provide the requested additional bathing capacities, as well as to provide stabilization of the shoreline.

Alternatives: Possible sites for additional beaches include the south face of Grass Island, west face of Grass Island, the area east of Jacobs Beach, Chittenden Beach and the area west of Chaffinch Island.

Grass Island does not provide a suitable area for beaches because of the difficulty of access through the Town of Madison. Also there are unsuitable offshore conditions including boulders on the outside of Grass Island and a shallow gravel area west of Grass Island. Parking would be required on the wetlands, which are regulated, and foundation problems also might be encountered. The extension of Jacobs Beach to the east would involve a conflict with the channel running adjacent to the shoreline at that location. A beach at Chittenden Beach would require a jetty at the west end to prevent the loss of sand into the West River. Much of the material at the jetty location is very soft and would provide a poor foundation for a jetty. Extra bracing would be required in order to stabilize a jetty at that location. Chaffinch Island has limited land area that is not salt marsh, so that parking may be a problem. Access to that area is through a narrow winding road. However, this does not appear to be a major problem.

The only reasonable sites for beach expansion are Chaffinch Island and Chittenden Beach.

CHITTENDEN BEACH

Functional & Environmental Factors: This beach area has an offshore muddy bottom that could interfere with the full utilization of the beach. There is presently a limited amount of parking available and is used for an adjacent playground. This shoreline is presently used for a nature study area. There does not appear to be any problem with traffic on the roads to the beach.

The marsh area behind the beach would be protected from further erosion, although a strip of marsh adjacent to the beach may be disturbed. The west end of the beach would require a jetty to contain sand and keep it out of the West River. Since the bottom material in the location of this jetty is very soft, a stone jetty would not be possible, and a heavily braced steel jetty would be required. In order to prevent sand from being washed back into the marsh, small depressions in the present dune would have to be filled in.

Economics: The bathing benefits for Chittenden Beach were estimated by two methods, one considering the beach as an overflow for Hammonasset Beach, the other as overflow for Jacobs Beach. The facility would also provide erosion prevention benefits.

The benefits for Chittenden Beach were estimated on the basis of the following conditions in addition to the general beach benefit conditions described in Appendix AA: The capacity of Chittenden Beach would be at least 1000 people, and sufficient parking capacity would be made available to serve this use.

The following optimum conditions were assumed to estimate the maximum benefits of the new beach as an overflow for Hammonasset Beach. Any of these factors could vary to produce lower benefits.

The Hammonasset parking capacity would continue to limit the capacity of the beach to 30,000 people. The daily demand at Hammonasset in 50 years would be double the attendance figures for 1972, with a linear growth during that time period. The new beach would be filled whenever Hammonasset was overflowed, neglecting the possibility that low tide might exist on overflow days, and assuming that people would know that the new beach was available.

Chittenden Beach would serve Hammonasset excess demand on 14 days during the 50th year based on the above conditions. These are equivalent to the 14 days when the observed attendance exceeded 15,000 people. The equivalent 50 year attendance would be double this amount or 30,000, which is the maximum capacity. Table XII Shows the observed and projected attendance figures for Hammonasset Beach. The observed figures are based on the "Statewide Comprehensive Outdoor Recreation Plan" dated 1973 by the Connecticut Department of Environmental Protection.

TABLE XII
HAMMONASSET BEACH ATTENDANCE

1972 RECORDS		50TH YEAR	
Attendance	Days Exceeded	Equivalent Demand ('72 Att. x 2)	Excess over 30,000 Capacity
30,000	2	60,000	30,000
25,000	5	50,000	20,000
20,000	10	40,000	10,000
15,000	14	30,000	0

The Chittenden Beach benefits for the 50th year would be the product of 14 days times 1000 people, times \$.85 per person, or \$12,000. The average annual equivalent benefits for Chittenden Beach, assuming a straight line growth of beach use, would be 3/10 of the peak year or \$3,600 as overflow for Hammonasset Beach.

Bathing benefits for Chittenden Beach were also considered based on conditions as an overflow for Jacobs Beach. The swimming classes presently use about 25% of the Jacobs Beach capacity on week days during the summer. It is assumed that both the daily use of the beach and the swim class sizes during the 50th year would be double the 1974 figures. It was assumed that the capacity of Jacobs Beach would continue to be limited to about 600 people per day. It was also assumed that no benefits would be derived on days when Jacobs Beach was not filled. The effects of other beaches were neglected. General basic conditions are described in Appendix AA.

Table 13 indicates the number of days that the Jacobs Beach attendance exceeded selected amounts in 1974. Projection of these records to the 50th year shows the number of days that demand would exceed the capacity by certain amounts. Integration of this pattern indicates a total excess demand of 8,000 people for that year at \$.85 per person, representing a benefit of \$7,000 for this peak year. At a straight line growth rate, the average annual benefit would be 3/10 of the peak year benefit, or \$2,100. Since this is much less than the benefit as Hammonasset overflow, it was assumed that the benefits would be based on Hammonasset rather than Jacobs Beach.

TABLE XIII
JACOBS BEACH ATTENDANCE

Weekends				Swimming Lesson Days				50th Year	
Number of Days Exceeded	1974 Attend.	50th Yr. Demand (2x'74)	Excess Over 600	Number Of Days Exceeded	1974 Attend.	50th yr. Demand (2x'74)	Excess Over 300	No. Of Days	Total Excess Demand
1	600	1200	600	1	450	900	600	2	600
1	500	1000	400	7	350	700	400	8	400
2	400	800	200	14	250	500	200	16	200
5	300	600	0	22	150	300	0	17	0

Total Excess Demand = $600 \times 27 \times 1/2 = 8,000$ for peak year

Excess up to 300 = $(300 \times 12) + 1/2 \times 300 \times 15 = 5850$

Erosion prevention benefits were based on the assumption that the shoreline would continue to erode at 2-1/2' per year. At a value of \$500 an acre for salt marsh, this represents a benefit of \$30.00 per year. Combined with the \$3600 bathing benefit as Hammonasset overflow, this gives a total benefit of \$3630 for Chittenden Beach.

Beach fill and jetty costs are based on the basic analysis factors in Appendix AA. Jetty costs are based on the use of corrosion resistant steel sheeting braced by batter piles. The costs for Chittenden Beach are shown on Table 14, which indicates a total annual cost of \$23,400.

TABLE XIV
COSTS
CHITTENDEN BEACH

Jetty - 400 ft. @ \$413/ft.	\$165,000.00	
Sandfill - 18,500 C.Y. @ \$4.00/C.Y.	<u>74,000.00</u>	
Basic Cost	\$239,000.00	
Contingencies (15)	<u>35,850.00</u>	
Construction	\$274,850.00	
Engineering & Design (8%)	\$ 21,988.00	
Supervision & Admin. (7%)	<u>19,239.50</u>	
First Cost	\$316,077.50	
Amortization (.00330)	1,043.06	per year
Interest (6-1/8%)	<u>19,359.75</u>	per year
Amortization & Interest	\$20,402.81	per year
Maintenance (1%)	<u>3,000.00</u>	per year
Annual Cost	\$23,402.81	per year

The benefit of \$3,630 per year and the cost of \$23,400 per year indicate an upper limit to the benefit cost ratio of 0.16 to 1 for Chittenden Beach.

CHAFFINCH ISLAND BEACH

Functional & Environmental Design Factors: The usability of Chaffinch Island Beach is limited by the space available for parking. Also the access road is narrow and winding. The shallow area offshore is somewhat muddy. It would be necessary to avoid disturbing the marsh behind the beach and a strip of the marsh probably would be disturbed although the beach would stabilize the marsh and prevent further loss of land. With adequate dune heights, a beach would be stable at this location and it would be contained at both ends by rock outcrops. The beach area is only partially Town owned and the Town would have to purchase the remainder of the cove.

Economics: Creation of a beach at Chaffinch Island would provide benefits for bathing and erosion prevention.

Bathing benefits would be limited by the non-marsh area available for parking. The beach is also remotely accessible. It is estimated that the peak capacity would be 300 people, based on parking limitations.

As an overflow for Hammonasset Beach the 300 person capacity for the 14 day peak year overflow days would result in a benefit of \$3,600 at \$0.85 per person. The average annual equivalent benefit would be 3/10 of the peak year value or \$1100 per year over the 50-year period.

As Jacobs Beach overflow, the peak year benefit would be \$5,000 based on the excess attendance of 5850 up to 300 people per day. The equivalent annual benefit would be 0.3 times the peak year benefit or \$1,500. This would be more significant than the Hammonasset benefit.

The shore erosion prevention benefits would be the same as Chittenden Beach, or \$30.00 a year. The total annual benefit would be \$1,530 per year.

The cost for sand fill for Chaffinch Island Beach is shown on Table 15, which indicates an annual cost of \$7,317.

The upper limit of the benefit cost ratio for Chaffinch Island Beach would be 0.2 to 1.

TABLE XV

COSTS

CHAFFINCH ISLAND BEACH

Volume	18,500 cu. yds.
Unit Price	\$4.00 per cu. yd.
Basic Cost	\$74,000
Contingencies (15%)	<u>11,100</u>
Construction	\$85,100
Engineering & Design (8%)	\$6,808
Supervision & Admin. (7%)	<u>5,957</u>
First Cost	\$97,865
Amortization (.00330)	323 per year
Interest (6-1/8%)	<u>5,994</u> per year
Amortization & Interest	\$6,317
Maintenance	<u>1,000</u>
Annual Cost	\$7,317 per year

SUGGESTIONS - BEACH EROSION CONTROL

No economic justification was found for any feasible beach erosion control improvement projects. However, some additional protection might be achieved by local interests through efforts to fill the gaps in the dunes along the Chaffinch Island and Chittenden Beach marshes. These dunes might be stabilized by planting beach grass and preventing people from wearing them down. If clean sand can be placed west of Chaffinch Island, this could retard erosion. The existing revetments might be strengthened if large stones are available to cover small stones or fill gaps.

SUMMARY

COORDINATION

Town Officials were consulted during the study to clarify the desires of the people and to collect information on the characteristics of the area, and the Town officials were kept informed of the progress of the study. The study was discussed with the Connecticut Department of Environmental Protection to advise them of the study and give them an opportunity to comment.

CONCLUSIONS:

None of the projects considered for Federal action were found to be economically feasible. In addition, there are some possible environmental factors that might develop under more detailed analysis of some of the alternatives which may discourage their execution.

RECOMMENDATIONS:

It is recommended that no Federal projects be undertaken. However, there are possibilities of local improvements including closer moorings in the East River anchorage, the extension of the Town Marina as planned, additional moorings and channel improvements in the West River, filling the gaps and stabilizing the dunes along the marsh areas, placing sand beside Chaffinch Island, and reinforcing the revetments at the Town Marina and Neck Road.

APPENDIX AA-DESIGN CRITERIA & BASIC FACTORS

NAVIGATION PROJECTS

Benefits: Recreational boating benefits were based on the increase in the annual return that would be received using a boat as rental. Boat values were 1975. The design distribution of boats was assumed to be similar to those used in the Poquonock River study. An anchorage density of 13 boats per acre was assumed based on single moorings with overlapping circles. Anchorage benefits were assumed to be 95% due to the inconvenience of having to get to shore from the offshore moorings.

First Costs: The quantities for breakwaters were minimum based on the assumption of firm foundations. The limited available subsurface data does not indicate any soft material in the area of the breakwaters. If the breakwaters are constructed with the top elevation at 12-1/2 feet above mean sea level, this will prevent wave overtopping except in occasional severe storms. This would occur at a spring tide elevation of 6.4 feet with a 3-foot storm surge and a 6-foot wave. Breakwaters would have a top width of 10 feet and 2-1 side slopes.

Armor stones weighing 4 to 6 tons would be stable under more severe wave attack from 50 knot winds.

Dredging costs are minimum based on the assumption that an acceptable spoil site would be available within a reasonable distance, both for the original dredging and the maintenance dredging. It was also assumed that there would be no ledge encountered. However, the rock outcrops in the harbor indicate that this may be a problem. Stone costs were based on assumption that an adequate supply of suitable stone would be available within a reasonable distance. The location of a suitable disposal site for dredged material may be difficult if the material is organic or not suitable for offshore sites. There are very few areas available for spoil on land. The dredging spoil material could be used to extend the existing marsh west of Grass Island. However, the necessary diking would be very expensive.

Cost estimates were based on a 15% contingency, 7-8% engineering and design, and 7% supervision and administration.

Annual Costs: First costs were amortized over 50 years at an interest rate of 6-1/8%. Maintenance costs were based on assumed frequencies of maintenance. Anchorages were assumed to be maintained every five years requiring approximately 20% of the original quantity. It was assumed that the breakwaters would be fairly stable and would require an average of 1% maintenance per year.

BEACH EROSION PROJECTS

Benefits: The land value for marshes was based on the maximum value paid by the State for salt marsh.

Bathing Benefits were based on the following conditions:

- 1) Population projections for extension of bathing demand was assumed to be a linear doubling in fifty years as a maximum condition. Data in the Long Island Sound Regional Study by the New England River Basins Commission indicates about a 70% growth.
- 2) Beach use was based on 75 square feet per person utilizing 75 feet of "dry" beach width as observed at Jacobs Beach.
- 3) Beaches in Guilford Harbor would be used by only one group per day because of the poor conditions at low tide. This has been the experience of Jacobs Beach.
- 4) A new beach would not provide any additional benefits on those days when existing beaches are not filled, because this would not constitute an increase in beach use, but rather a transfer.
- 5) It was assumed that no other new beaches will provide the needed extra capacity.
- 6) The benefits per person would be \$.85 per day, based on fees at other beaches and facilities available.

Costs: The sandfill costs are based on the typical natural beach profile in the area which has a berm five feet above mean high water and a face slope of 1:10. This has been observed in a study of beach surveys as reported in "Beach Behavior, North Shore, Long Island Sound" by Robert A. McCabe, published in the American Society of Civil Engineers Proceedings Paper #7639 in November, 1970. If sand is pumped in hydraulically, the new fill will tend to assume a temporary flatter slope. A dry beach width of 100 feet at mean high water is considered adequate as a buffer from severe storms, and for bathing capacity.

It is assumed that suitable sand could be obtained within a reasonable distance at inland sandpits or offshore without causing environmental problems.

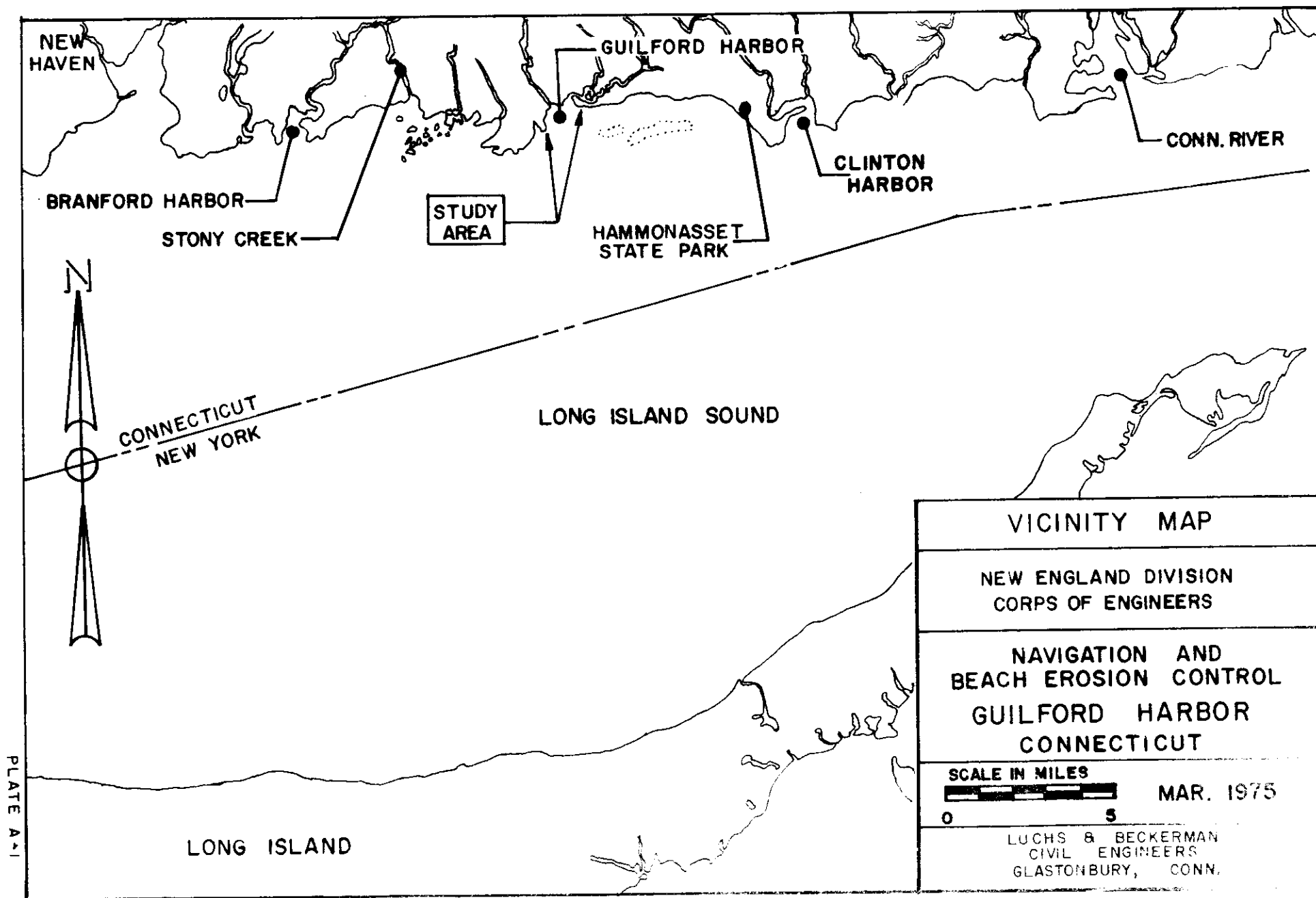
Jetty costs are based on the assumption that the muck found at one location is present at only a limited portion of the jetty. If the muck is extensive, the jetty cost would be much greater. The jetty would not be subject to wave impact except at glancing angles with limited head differentials.

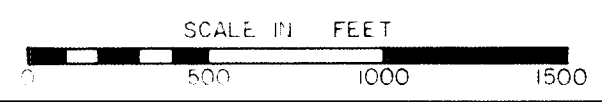
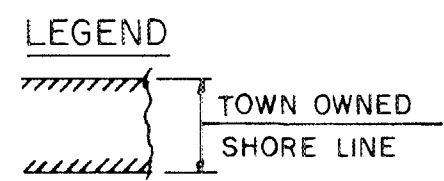
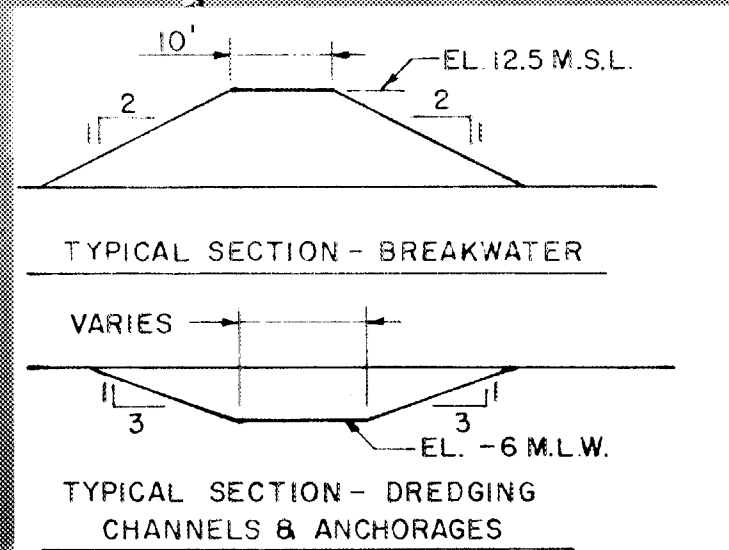
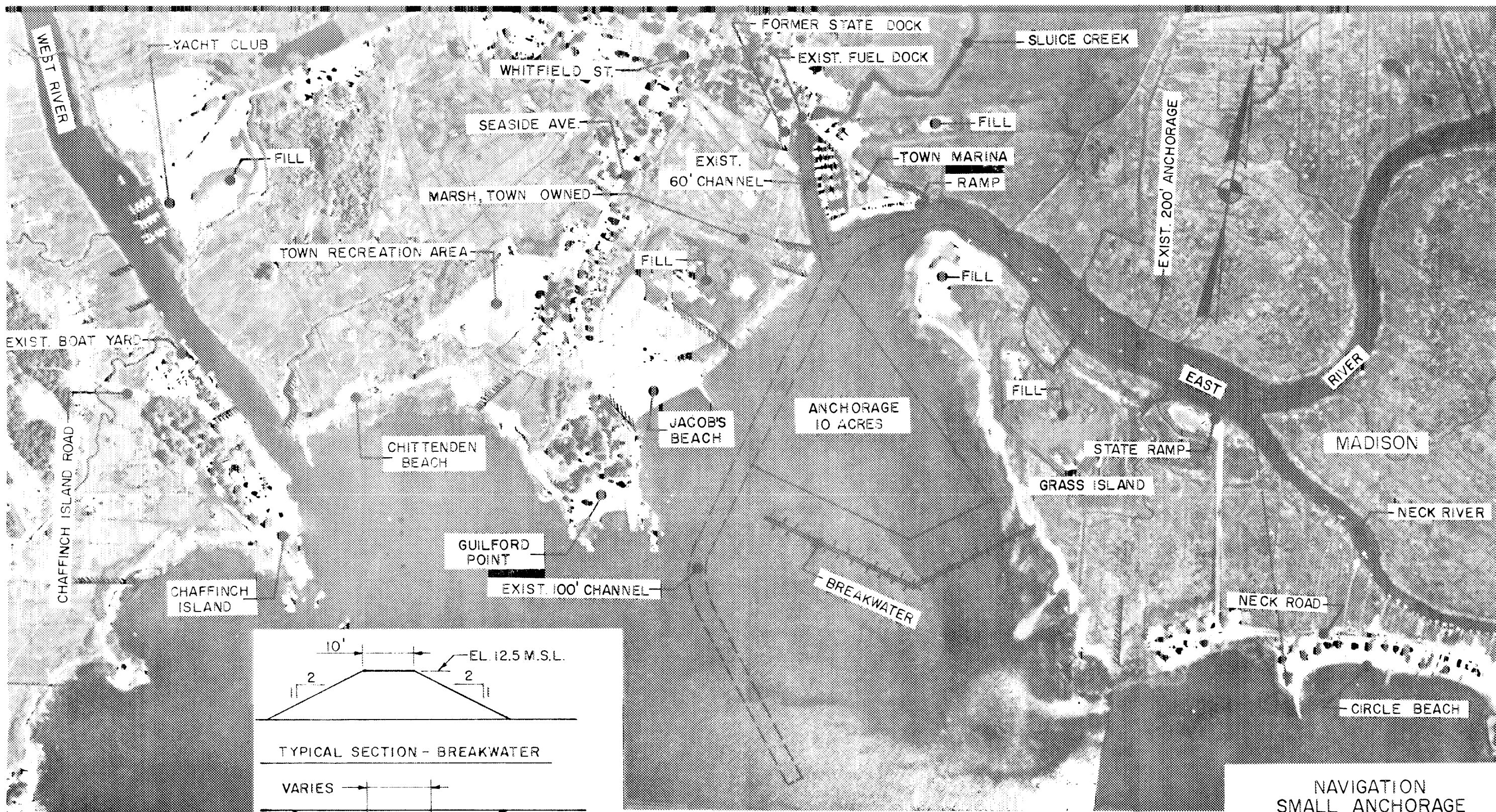
Revetments were assumed to be subject to 6-foot breaking waves which would require 1 to 2 ton stones at a 2:1 slope.

Unit costs were based on experience. However, due to the lack of recent projects in the near vicinity under similar conditions, the prices had to be based on more remote projects.

APPENDIX BB-BEACH EROSION BACKGROUND DATA

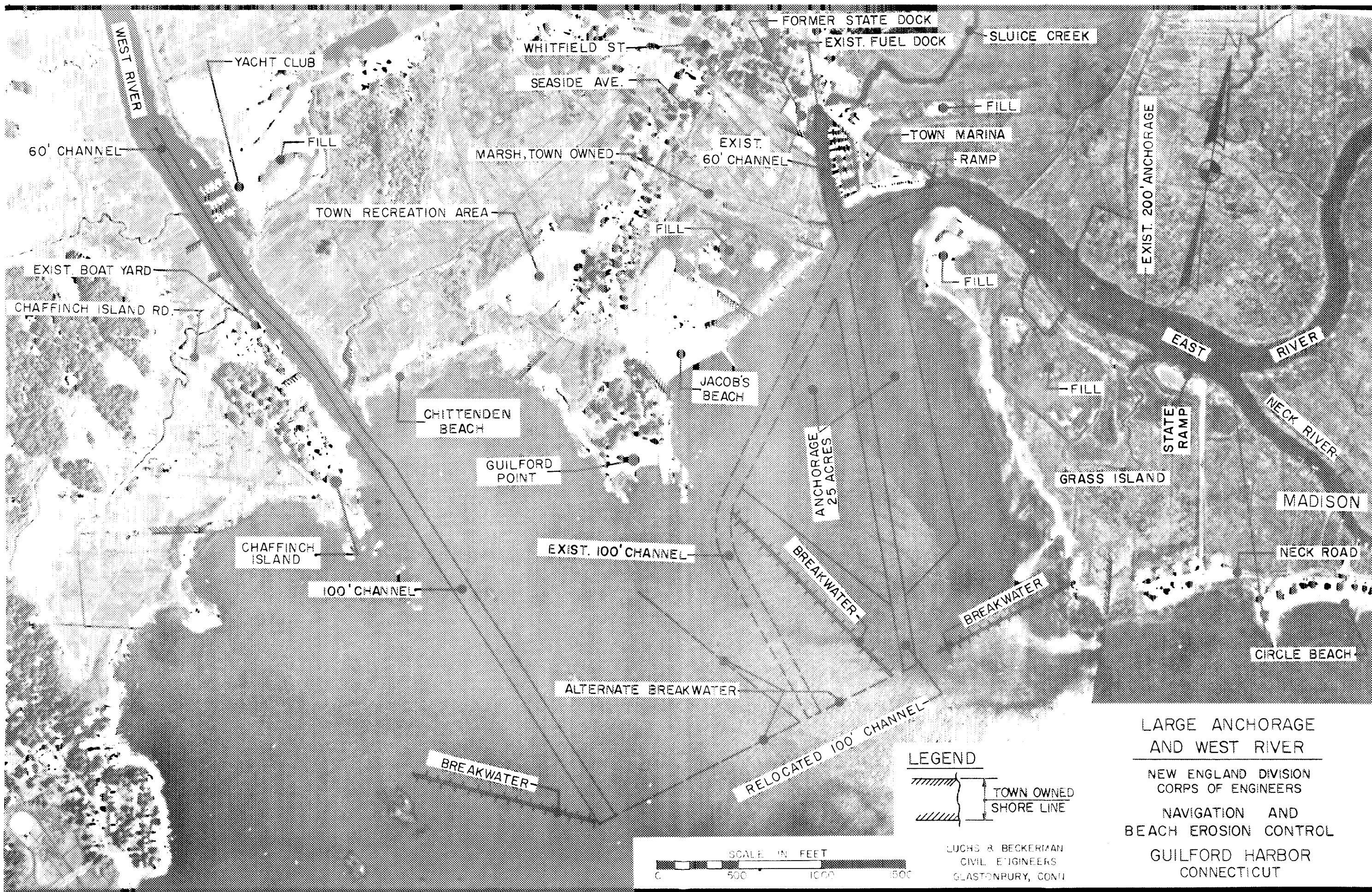
The shoreline of Guilford Harbor is essentially salt marsh area with a few rock outcrops at Mulberry Point, Chaffinch Island, Guilford Point, and a small outcrop west of Chaffinch Island. The only littoral material evident in the area is sand moving along the face of Grass Island and working down the shoreline from Madison, eventually ending up in the East River mouth. Some silt is disturbed off the floor of the harbor. The tide range is 5-1/2 feet. The maximum tidal current along the shore is about 1-1/2 knots. The shore is exposed to a fetch of twenty miles from the southeast to the southwest. The height of breaking waves within the harbor is somewhat limited, due to the bench approximately 3 feet below mean low water which would break deep waves at low tide. The erosion can partly be attributed to waves pushing unconfined material along the shore. Some material can also be washed back over low dunes by high waves. The marsh recession, particularly in the confined area west of Chaffinch Island, might also be due to the relative bouyancy of the organic material. This might be more easily washed out than mineral soils, such as sand.





LUCHS & BECKERMAN
CIVIL ENGINEERS
GLASTONBURY, CONN.

NAVIGATION
SMALL ANCHORAGE
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
NAVIGATION AND
BEACH EROSION CONTROL
GUILFORD HARBOR
CONNECTICUT



SENATE RESOLUTION 148

GUILFORD SHORES, GUILFORD, CONNECTICUT

Information called for by Senate Resolution 148, 85th Congress, adopted 28 January 1958.

1. Guilford Harbor is located on the north side of Long Island Sound, about 13 miles east of New Haven Harbor. There is an existing Federal navigation project in the harbor which provides for a channel 6 feet deep at mean low water, 100 feet wide through the harbor from Long Island Sound to an anchorage basin in East River which is 6 feet deep, 200 feet wide and 1,500 feet long. The project also includes a branch channel 6 feet deep, 60 feet wide up Sluice Creek to Whitfield Street, about 0.8 miles long. The existing project was completed in 1958. There is also an existing beach erosion control project at Guilford Point public beach. The project consists of a 300-foot long impermeable groin and sandfill. The project was completed in 1959.

2. Navigation and Beach Erosion Problems. The principal navigation problems evolve from a need for more space to moor boats and the need for a deeper access from the West River to deep water. The beach erosion problems consist of shoreline losses in salt marsh areas which have been receding at a rate of 2 1/2 feet per year.

3. Improvements Considered. Three plans of improvement were considered for increasing the anchorage space in the harbor. One was a small anchorage at the mouth of the East River. The other two were larger anchorages with breakwaters extending out to the entrance channel. Consideration was given to dredging a channel 6 feet deep at mean low water, 100 feet wide, extending from deep water in Long Island Sound upstream in the West River to the existing yacht club. The channel would be protected by a 1000 foot long breakwater adjacent to the west side of the entrance. Additional loss of land fronting the salt marshes could be reduced by placement of a barrier such as revetments, seawalls or similar structures.

4. Discussion. The economic and environmental feasibility study for navigation improvements and beach erosion control revealed that although there is a need for additional mooring space and shore protection, the estimated cost exceeded the anticipated benefits and that all considered plans were not economically justified for Federal participation at this time. However, there are possibilities of local interests providing closer moorings in the East River

anchorage, enlarging the Town Marina, providing additional moorings and channel improvement in the West River, filling the gaps and stabilizing the existing shoreline fronting the salt marshes, placing sand at Chaffinch Island, and reinforcing the existing shore revetments at the Town Dock and Neck Road.